

U.S. Patent Application Serial No. 09/664,332
Response dated May 13, 2004
Reply to OA of **January 15, 2004**

REMARKS

Claims 1-3, 6-10, 12, 17-19 and 21-28 are pending in this application. Claims 9, 17-19, 21 and 23-26 are withdrawn from consideration. Applicants respectfully note that the Examiner incorrectly lists claim 28 as withdrawn in box 4(a) of the Office Action Summary page. No amendment is made in this Response.

Claims 1-3, 6-8, 10, 12, 22, 27 and 28 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Hamazu et al., Buchwalter et al., Starkey and Green '592 in view of Green et al. '938.

The Examiner has maintained this rejection from the Office action of July 24, 2003. The Examiner indicates that the amendment inserting "by chain reaction" is supported by the specification, but then states:

"The cited prior art embraces the claimed possibility for the reasons espoused on pages 2 and 3 of the advisory action."

That is, the Examiner indicates that he considers the prior art initiators to teach the "by chain reaction" limitation, although he does not specifically indicate where this is taught.

Applicants respectfully traverse the rejection of claims 1-3, 6-8, 10, 12, 22, 27 and 28. In traversing the rejection, Applicants submit that the curing "by chain reaction" recited in the present claims is not disclosed in any of the references.

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Applicants believe that further clarification of the “curing by chain reaction” (“chain curing”) mechanism of the present invention will serve to clarify the distinction between the present claims and the prior art. Therefore, attached to this Response is a **Declaration under 37 CFR 1.132** by **Noriya HAYASHI**, inventor of the present application. In this Declaration, Mr. Hayashi presents the results of an experiment demonstrating the difference between **chain curing** of the present invention and conventional photo curing. Mr. Hayashi also presents general remarks about the nature of “chain curing” and on the prior art.

In particular, the Experimental section of the Declaration presents the results of chain curing a resin composition of the present invention, compared to the resin component used only as reference (ref). In the inventive case, the temperature can be seen to rise significantly in upper, middle and lower depths, while the temperature rise in these depths of the reference sample is much smaller. This demonstrates that “curing by chain reaction” is different from conventional curing.

As discussed in the Analysis portion of the Declaration under 37 CFR 1.132, none of the references cited by the Examiner discloses or suggests the technical idea of curing resin by chain reaction. In the conventional energy-ray curing shown in the references, curing does not proceed at a depth where no light reaches. The mechanism of heat-curing also differs from the chain curing of the present invention.

In particular, the cited references do not disclose the use of a compound represented by structural formula (IV), (IV') or (V).

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Applicants therefore submit that claims 1-3, 6-8, 10, 12, 22, 27 and 28 are novel and non-obvious over Hamazu et al., Buchwalter et al., Starkey, Green '592, and Green et al. '938, taken separately or in combination.

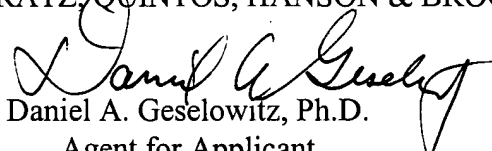
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If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact Applicant's undersigned agent at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

In the event that this paper is not timely filed, Applicant respectfully petitions for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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PATENT TRADEMARK OFFICE

Enclosures: Declaration under 37 CFR 1.132



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

HAYASHI, Noriya

Serial No.: **09/664,332**

Group Art Unit: **1712**

Filed: **September 18, 2000**

Examiner: **Robert E. Sellers**

For: **ENERGY RAY-CURING RESIN COMPOSITION**

DECLARATION UNDER 37 CFR § 1.132

Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, NORIYA HAYASHI, of c/o Nagoya Research & Development Center, MITSUBISHI HEAVY INDUSTRIES, LTD., 1-Takamichi, Iwatsuka-cho, Nakamura-kyu, Nagoya-shi, Aichi-ken, Japan, declare and state;

- 1) That I am the inventor of the instant invention, and
- 2) That the experiments given below were carried out under my general direction and supervision.

I, the undersigned, declare that all statements made herein of my own knowledge are true and that all statements made of information and belief are believed to be true; and further that these statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Introduction

The currently pending claims recite a composition comprising a photopolymerizable resin component and a component which is "a photopolymerization initiator component which makes it possible to cure **by chain reaction** said photopolymerizable resin". The photopolymerization initiator component is specified by the structural formula (IV), (IV'), or (V). The curing mechanism by a specific photopolymerization initiator component of the present invention **by chain reaction** (i.e., **chain curing**) is distinguished from conventional photo curing and heat curing. The most remarkable difference of the chain curing from photo and heat curing is that, once the chain curing begins, curing proceeds being continuously propagated by the heat generated from its own chain curing reaction heat, even after provision of energy is stopped, whereas photo curing and heat curing require continuous energy provision to complete the curing. Therefore, in the present invention, **resin can be cured at a depth where no light reaches.**

This chain curing itself is found to be a new phenomenon that is different from conventionally known concepts of chain reaction by radical, and has never been known in the field of photo and heat curing. By utilizing this specific phenomenon, the present inventors have found the composition of the present invention by optimizing each of the composition components which have been selected and experimented based on a completely new basis. Accordingly, **the composition of the present invention is completely different** from conventional photo and heat curing in that the composition of the present invention is a composition to cure continuously.

Experimental

Applicants here present the results of experiments demonstrating the difference between **chain curing** of the present invention and conventional photo curing.

Attached Figure A shows the change in temperature during chain curing of the resin composition of the present invention. The change in temperature of the resin component only is also shown as a comparison (Refer to "ref" in the Figure). In the experiment, a UV irradiation apparatus, UVL-1500M2 which has also been used in Example 2, was used and the irradiation distance was 17 cm. The vertical line shows a temperature of each depth (upper, middle and lower) and the horizontal line shows the irradiation time. As can be seen in Figure A, the resin composition of the present invention generated heat even at a lower depth during chain curing, while the temperature of the resin component (only) did not rise even when the same resin as used in the present invention was used. From the results of Figure A, it can be concluded that the specific phenomenon of curing by chain reaction (i.e., chain curing) will occur for the specific resin composition.

Analysis and further comments

As noted above, the photopolymerization initiator component included in the resin composition of the present invention refers to (is limited to) "a component which makes it possible to cure by chain reaction" which is specified by the structural formula (IV), (IV') or (V).

None of References cited by the Examiner discloses the component "which makes it possible to cure by chain reaction" or suggests the technical idea of curing resin by chain reaction. Further, the References do not disclose the use of the compound represented by the structural formula (IV), (IV') or (V) at all.

In contrast, the present invention is achieved based on the technical idea of curing resin by chain reaction. The present inventors have found that the compound represented by the formula (IV), (IV') or (V) is a component that makes it possible to cure by chain reaction. Thus, in the present invention, the compound represented by the formula (IV), (IV') or (V) is used as a photopolymerization initiator component. In addition, the amount ratio of the compound should be

within an adequate range. In other words, it is important that the compound is included in the ratio of 0.1 - 6.0 wt% in the resin composition in order to cure by chain reaction.

Further, in the composition comprising only the specific sulfonium salt of the formula (IV), (IV') or (V), chain curing does not occur. In order to generate chain curing, co-existence of both the specific sulfonium salt and an acid anhydride is necessary. Thus, the composition of the present invention includes both the compound specified by the formula (IV), (IV'), or (V) which is not disclosed in the References and an acid anhydride. The function of curing resin by chain reaction can be performed by the co-existence of the compound specified by the formula (IV), (IV') or (V) and an acid anhydride. The amount ratio of the acid anhydride is determined by the mechanism of curing resin by chain reaction and is thus in the range of 0.3 - 1.4 mol with respect to 1 mol of the resin component. If the amount of the acid anhydride is too small, curing does not proceed sufficiently. On the other hand, if the amount is too large, the resin component required for curing becomes less and the curing characteristics thus deteriorate.

In a system wherein an acid anhydride is added to a general sulfonium salt other than the specific sulfonium salt of the formula (IV), (IV') or (V), chain curing does not occur. This fact was shown in the test results (of Added Comparative Example 1 and 2) of the Declaration submitted to the U.S. Patent and Trademark Office on March 3, 2003. In addition, in a system in which an acid anhydride is added to the photopolymerization initiator described in U.S. Patent Nos. 5,879,859, 5,384,339, or the like, chain reaction does not occur.

The following is an explanation based on experimental examples to show that the composition specified in the present invention meets the specific requirements to perform chain curing.

In Comparative Examples 2 and 3 of the present invention, described on pages 75-76 of the specification, a composition with an acid anhydride having been removed was examined. That is,

a composition was prepared in which the specific sulfonium salt was mixed with a resin component and an acid anhydride was removed. The sample did not cause chain curing and was cured only on its surface, wherein the remainder was not cured. Thus, adding an acid anhydride to a resin is indispensable as a precondition to perform chain curing, and the preferable amount of the acid anhydride is in the range of 0.3 - 1.4 mole with respect to 1 mol of the resin component.

In Added Comparative Examples 1 and 2 submitted with the Declaration on March 3, 2003, a composition using a general sulfonium salt other than the specific sulfonium salt of the formula (IV), (IV'), or (V) was examined. In Added Comparative Example 1, a composition was prepared in which an aryl sulfonium salt type polymerization initiator was blended with a resin in which an acid anhydride was added. The sample did not cause chain curing and was cured only on its surface, wherein the remainder was not cured. In Added Comparative Example 2, a composition was prepared in which a cation sulfonium salt type polymerization initiator was blended with a resin in which an acid anhydride was added. The sample also did not cause chain curing and was cured only on its surface, wherein the remainder was not cured.

In contrast, the composition of the present invention includes a compound having a specific structural formula represented by a general formula (IV). The composition in a glass vessel (Ø40 mm x H50 mm) in which a specified amount of the compound of the general formula (IV) and an acid anhydride (maleic anhydride) were blended with a resin was completely cured by chain curing in a few minutes.

From the above results, in a system wherein an acid anhydride is added to a sulfonium salt other than the specific sulfonium salt of the structural formula (IV), (IV') or (V), chain curing does not occur even if a cation sulfonium salt type polymerization initiator described in the References was used. Thus, even if the References that do not disclose the component "which makes it possible to cure by chain reaction" specified by the formula (IV), (IV') or (V) were combined, their

combination could not have reached the present invention, i.e., energy-ray curing resin composition by chain curing. In addition, the skilled person could not have prepared the composition of the present invention by combining other structural component in anticipation of chain reaction, since the References do not suggest chain curing at all.

The functional effect to achieve chain curing of the present invention is completely different from that of the References and the effect is extremely remarkable.

In the conventional energy-ray curing shown in the References, although curing of a resin component itself proceeds by a photopolymerization initiator, curing does not proceed at a depth where no light reaches or where no light exists. Further, even if the features of the References are combined, complete curing cannot be performed at a depth where no light reaches in just a few minutes unless chain curing is achieved. In addition, in heat curing, since a heating device and a heating step (for a certain amount of time) are additionally required, curing in a short time with a simplified device as used in energy-ray curing is impossible.

Noriya Hayashi

Noriya HAYASHI

Signed this 12 day of May, 2004

Temperature changes of resin

Fig. A

